Alternative Selection Criteria for Package A

California Statewide Utility Codes and Standards Program

McHugh Energy Consultants

ENERGY SOLUTIONS HMG

Our understanding of CEC measure selection process

- “Package A” Residential prescriptive measures to replace default Component Package D in current T-24 standard
- Measures have been chosen based on cost-effectiveness and …
- … first cost does not exceed $3,800 (weighted cost not exceed $2,800)

Our understanding of affordability

- If sum of mortgage cost and energy costs is less expensive with higher levels of efficiency, does this first cost “cap” make sense?
- Can we use other metrics to determine when there is enough (or too much) efficiency?
- Additional cost-effective measures are feasible
  - Especially in hottest climate zones with high air conditioning loads

Variations on Package A

- Package A1 – maximum efficiency considered in runs,
  - Packages are cost-effective in each climate zone when all measures taken together
  - could still go further and be cost-effective
- Package A2 – “minimum life cycle cost”
- Package A3 – CEC recommended proposal
  - Political feasibility in addition to cost-effective
  - Cap placed on first cost

Approach to Parametric Analysis

- Vary one measure at a time with all other measures having maximum efficiency value
  - All other measures have package A1 criteria
- Color code all measures which are cost-effective
  - B/C ratio > 1.0, real discount rate = 3%
  - Residential period of analysis = 30 years
- Record key parameters
  - Life cycle savings
  - First cost
  - Present value of energy cost savings
  - Benefit/Cost ratio

Approach to Cash Flow Analysis

- Customer viewpoint cash flow analysis
- Nominal discount rate = 5%
  - Interest rate of a 30 year fixed interest mortgage
- Nominal energy escalation rate = 2%
- Real Discount = Nominal Discount – Nominal Escalation
  - 3% = 5% - 2%
- Period of analysis = 30 years
  - Term of typical residential mortgage
- Down payment = 10%
  - Typical down payment
- Cash flow metrics
  - Annual net cost: Payments – Utility Cost Savings (nominal)
  - Cumulative Net Cost: Sum of annual net costs from Year 0 (nominal)
  - Discounted Cumulative Net Cost: Nominal discount rate applied to annual net costs (discounted, time value of money)

Cash flow Analysis of Wall Insulation Measure

Description	Value
Nominal discount rate	5%
Nominal escalation rate	2%
Real discount rate	3%
Percent down payment	10%
Period of analysis (yr)	30
Present worth multiplier	19.60
CTZ 09 - Wall insulation	
Base (CEC) case R-15 W/ R-4 ci	
Proposed R-21, 24" OC w/ R-4 ci	
Incremental Cost	$ 450.82
Down payment	$ 45.08
Loan Principal amount	$ 405.74
Loan payment amount	$26.39
PV Energy Cost Savings	$ 731.27
1st year Energy Cost Savings	$ 37.31
Net Life Cycle Savings	$ 280.45
B/C Ratio	1.622

Year No	Payment	Utility Savings	Net Cost	Cumulative net cost	Discounted Cumulative net cost
0	$45.08		$45.08	$45.08	$45.08
1	$26.39	$38.06	($11.66)	$33.42	$33.98
2	$26.39	$38.82	($12.42)	$21.00	$22.71
3	$26.39	$39.59	($13.20)	$7.80	$11.31
4	$26.39	$40.38	($13.99)	($6.19)	($0.20)
5	$26.39	$41.19	($14.80)	($20.99)	($11.80)
6	$26.39	$42.02	($15.62)	($36.61)	($23.45)
7	$26.39	$42.86	($16.46)	($53.07)	($35.15)
8	$26.39	$43.71	($17.32)	($70.39)	($46.88)
9	$26.39	$44.59	($18.19)	($88.59)	($58.60)
10	$26.39	$45.48	($19.09)	($107.67)	($70.32)
11	$26.39	$46.39	($20.00)	($127.67)	($82.01)
12	$26.39	$47.32	($20.92)	($148.59)	($93.66)
13	$26.39	$48.26	($21.87)	($170.46)	($105.26)
14	$26.39	$49.23	($22.83)	($193.29)	($116.79)
15	$26.39	$50.21	($23.82)	($217.11)	($128.25)
16	$26.39	$51.22	($24.82)	($241.94)	($139.62)
17	$26.39	$52.24	($25.85)	($267.78)	($150.90)
18	$26.39	$53.29	($26.89)	($294.68)	($162.07)
19	$26.39	$54.35	($27.96)	($322.63)	($173.14)
20	$26.39	$55.44	($29.05)	($351.68)	($184.08)
21	$26.39	$56.55	($30.15)	($381.83)	($194.91)
22	$26.39	$57.68	($31.28)	($413.12)	($205.60)
23	$26.39	$58.83	($32.44)	($445.56)	($216.16)
24	$26.39	$60.01	($33.62)	($479.17)	($226.59)
25	$26.39	$61.21	($34.82)	($513.99)	($236.87)
26	$26.39	$62.43	($36.04)	($550.03)	($247.00)
27	$26.39	$63.68	($37.29)	($587.31)	($256.99)
28	$26.39	$64.96	($38.56)	($625.88)	($266.83)
29	$26.39	$66.25	($39.86)	($665.74)	($276.51)
30	$26.39	$67.58	($41.19)	($706.92)	**($286.04)**

Cash flow Analysis of Duct Insulation Measure

Description	Value
Nominal discount rate	5%
Nominal escalation rate	2%
Real discount rate	3%
Percent downpayment	10%
Period of analysis (yr)	30
Present worth multiplier	19.60
CTZ 12 - Duct insulation	
Base (CEC) case R-6	
Proposed case R-8	
Incremental Cost	$ 151.61
Downpayment	$ 15.16
Loan Principal amount	$ 136.45
Loan payment amount	$8.88
PV Energy Cost Savings	$ 163.36
1st year Energy Cost Savings	$ 8.33
Net Life Cycle Savings	$ 11.75
B/C Ratio	1.078

Year No	Payment	Utility Savings	Net Cost	Cumulative net cost	Discounted Cumulative net cost
0	$15.16		$15.16	$15.16	$15.16
1	$8.88	$8.50	$0.38	$15.54	$15.52
2	$8.88	$8.67	$0.20	$15.74	$15.70
3	$8.88	$8.84	$0.03	$15.77	$15.73
4	$8.88	$9.02	($0.15)	$15.63	$15.61
5	$8.88	$9.20	($0.33)	$15.30	$15.36
6	$8.88	$9.39	($0.51)	$14.79	$14.98
7	$8.88	$9.57	($0.70)	$14.09	$14.48
8	$8.88	$9.77	($0.89)	$13.21	$13.88
9	$8.88	$9.96	($1.08)	$12.12	$13.18
10	$8.88	$10.16	($1.28)	$10.84	$12.39
11	$8.88	$10.36	($1.49)	$9.35	$11.52
12	$8.88	$10.57	($1.69)	$7.66	$10.58
13	$8.88	$10.78	($1.91)	$5.75	$9.57
14	$8.88	$11.00	($2.12)	$3.63	$8.50
15	$8.88	$11.22	($2.34)	$1.29	$7.37
16	$8.88	$11.44	($2.57)	($1.28)	$6.20
17	$8.88	$11.67	($2.79)	($4.07)	$4.98
18	$8.88	$11.90	($3.03)	($7.10)	$3.72
19	$8.88	$12.14	($3.27)	($10.36)	$2.43
20	$8.88	$12.38	($3.51)	($13.87)	$1.10
21	$8.88	$12.63	($3.76)	($17.63)	($0.24)
22	$8.88	$12.88	($4.01)	($21.64)	($1.61)
23	$8.88	$13.14	($4.27)	($25.90)	($3.00)
24	$8.88	$13.41	($4.53)	($30.43)	($4.41)
25	$8.88	$13.67	($4.80)	($35.23)	($5.82)
26	$8.88	$13.95	($5.07)	($40.30)	($7.25)
27	$8.88	$14.23	($5.35)	($45.65)	($8.68)
28	$8.88	$14.51	($5.63)	($51.28)	($10.12)
29	$8.88	$14.80	($5.92)	($57.21)	($11.56)
30	$8.88	$15.10	($6.22)	($63.43)	**($13.00)**

Years to Positive Cash Flow Metrics for Various Benefit/Cost Ratios

Benefit/Cost Ratio	Years to Positive Cash Flow	Years to Cumulative Positive Cash Flow	Years to Discounted Cumulative Positive Cash Flow
1.1	3	15	19
1.3	1	8	9
1.5	1	5	6
1.7	1	4	4
2.0	1	3	3
2.5	1	2	2
3.0	1	2	2
5.0	1	1	1

Pick a metric and a period to payback, before looking at B/C results

Duct Insulation (Note Roof Insulation is per Max Savings Package A1)

Climate Zone	Max Savings	CEC Prop	LCC Saved	1st Cost	Energy Cost Savings	
CTZ	Duct R-value	Code	PV $	$	PV $	B/C
1	R-8	R-6	-$0.77	$151.61	$150.84	0.99
2	R-8	R-6	-$47.73	$151.61	$103.88	0.69
3	R-8	R-6	-$88.34	$151.61	$63.27	0.42
4	R-8	R-6	-$53.20	$151.61	$98.41	0.65
5	R-8	R-6	-$103.35	$151.61	$48.26	0.32
6	R-6	R-6	$0.00	$0.00	$0.00	#DIV/0!
7	R-6	R-6	$0.00	$0.00	$0.00	#DIV/0!
8	R-6	R-6	$0.00	$0.00	$0.00	#DIV/0!
9	R-8	R-6	-$38.69	$151.61	$112.92	0.74
10	R-8	R-6	-$25.49	$151.61	$126.12	0.83
11	R-8	R-6	$184.58	$151.61	$336.19	2.22
12	R-8	R-6	$11.75	$151.61	$163.36	1.08
13	R-8	R-6	$178.56	$151.61	$330.17	2.18
14	R-8	R-8	$0.00	$0.00	$0.00	#DIV/0!
15	R-8	R-8	$0.00	$0.00	$0.00	#DIV/0!
16	R-8	R-8	$0.00	$0.00	$0.00	#DIV/0!

Infiltration Reduction

Climate Zone	Max Savings	CEC Prop	LCC Saved	1st Cost	Energy Cost Saved	
CTZ	Infiltration	Infiltration	PV $	$	PV $	B/C
1	3 ACH 50	4 ACH 50	-$32.53	$156.62	$124.10	0.79
2	3 ACH 50	4 ACH 50	-$67.50	$156.62	$89.12	0.57
3	4 ACH 50	7.5 ACH 50	-$242.31	$656.10	$413.79	0.63
4	3 ACH 50	7.5 ACH 50	-$112.44	$812.72	$700.29	0.86
5	3 ACH 50	7.5 ACH 50	-$227.08	$812.72	$585.65	0.72
6	3 ACH 50	7.5 ACH 50	-$588.95	$812.72	$223.77	0.28
7	7.5 ACH 50	7.5 ACH 50	$0.00	$0.00	$0.00	#DIV/0!
8	3 ACH 50	7.5 ACH 50	-$331.50	$812.72	$481.22	0.59
9	3 ACH 50	7.5 ACH 50	$40.04	$812.72	$852.76	1.05
10	3 ACH 50	4 ACH 50	$53.28	$156.62	$209.90	1.34
11	3 ACH 50	4 ACH 50	$175.61	$156.62	$332.23	2.12
12	3 ACH 50	4 ACH 50	$68.41	$156.62	$225.03	1.44
13	3 ACH 50	4 ACH 50	$141.52	$156.62	$298.14	1.90
14	3 ACH 50	4 ACH 50	$169.56	$156.62	$326.18	2.08
15	3 ACH 50	4 ACH 50	$303.11	$156.62	$459.74	2.94
16	3 ACH 50	4 ACH 50	$52.56	$156.62	$209.19	1.34

Quality Insulation Installation Inspection (QII)

Climate Zone	Max Savings	CEC Prop	LCC Saved	1st Cost	Energy Cost Saved	
CTZ	QII	QII	PV $	$	PV $	B/C
1	QY	QN	$229.48	$709.00	$938.48	1.32
2	QY	QN	-$82.75	$709.00	$626.25	0.88
3	QY	QN	-$181.24	$709.00	$527.76	0.74
4	QY	QN	-$165.69	$709.00	$543.31	0.77
5	QY	QN	-$186.71	$709.00	$522.29	0.74
6	QY	QN	-$388.07	$709.00	$320.93	0.45
7	QY	QN	-$553.50	$709.00	$155.50	0.22
8	QY	QN	-$420.53	$709.00	$288.47	0.41
9	QY	QN	-$213.02	$709.00	$495.98	0.70
10	QY	QN	-$133.91	$709.00	$575.09	0.81
11	QY	QN	$373.17	$709.00	$1,082.17	1.53
12	QY	QN	$112.06	$709.00	$821.06	1.16
13	QY	QN	$299.60	$709.00	$1,008.60	1.42
14	QY	QN	$381.91	$709.00	$1,090.91	1.54
15	QY	QN	$204.80	$709.00	$913.80	1.29
16	QY	QN	$463.26	$709.00	$1,172.26	1.65

Roof Deck Insulation

Climate Zone	Max Savings	CEC Prop	LCC Saved	1st Cost	Energy Cost Saved	
CTZ	Roof Ins	Roof Ins	PV $	$	PV $	B/C
01	R-13 Under	No	-$300.67	$1,349.67	$1,049.00	0.78
02	R-13 Under	No	$21.44	$1,104.28	$1,125.72	1.02
03	R-13 Under	No	-$541.50	$1,104.28	$562.78	0.51
04	R-13 Under	No	-$268.29	$1,104.28	$835.99	0.76
05	R-13 Under	No	-$599.22	$1,104.28	$505.06	0.46
06	R-13 Under	No	-$285.65	$1,104.28	$818.63	0.74
07	R-13 Under	No	-$603.38	$1,104.28	$500.89	0.45
08	R-13 Under	No	$193.76	$1,104.28	$1,298.04	1.18
09	R-13 Under	R-4 Over	$699.45	$39.26	$738.71	18.81
10	R-13 Under	R-4 Over	$748.84	$39.26	$788.11	20.07
11	R-8 Over	R-4 Over	$534.88	$588.95	$1,123.83	1.91
12	R-13 Under	R-4 Over	$811.52	$39.26	$850.79	21.67
13	R-8 Over	R-4 Over	$675.50	$588.95	$1,264.45	2.15
14	R-8 Over	R-4 Over	$428.52	$588.95	$1,017.47	1.73
15	R-8 Over	R-8 Over	$0.00	$0.00	$0.00	#DIV/0!
16	R-8 Over	No	$235.34	$1,899.35	$2,134.70	1.12

Wall Insulation Comparison

Climate Zone	Max Savings	CEC Prop	LCC Saved	1st Cost	Energy Cost Saved	
CTZ	Wall Ins	Wall Ins	PV $	$	PV $	B/C
01	R-21 24"OC + R-4	R-21 16"OC + R-4	$131.75	$0.00	$131.75	#DIV/0!
02	R-21 24"OC + R-4	R-15 16"OC + R-4	$536.59	$450.82	$987.41	2.19
03	R-21 24"OC + R-4	R-15 16"OC + R-4	$298.74	$450.82	$749.56	1.66
04	R-21 24"OC + R-4	R-15 16"OC + R-4	$381.43	$450.82	$832.25	1.85
05	R-21 24"OC + R-4	R-15 16"OC + R-4	$315.93	$450.82	$766.75	1.70
06	R-21 24"OC + R-4	R-15 16"OC + R-4	$30.87	$450.82	$481.68	1.07
07	R-19 24"OC + R-4	R-15 16"OC + R-4	-$34.52	$195.15	$160.63	0.82
08	R-21 24"OC + R-4	R-15 16"OC + R-4	-$12.48	$450.82	$438.34	0.97
09	R-21 24"OC + R-4	R-15 16"OC + R-4	$280.45	$450.82	$731.27	1.62
10	R-21 24"OC + R-4	R-15 16"OC + R-4	$399.51	$450.82	$850.32	1.89
11	R-21 24"OC + R-4	R-21 16"OC + R-4	$105.56	$0.00	$105.56	#DIV/0!
12	R-21 24"OC + R-4	R-21 16"OC + R-4	$70.04	$0.00	$70.04	#DIV/0!
13	R-21 24"OC + R-4	R-21 16"OC + R-4	$97.15	$0.00	$97.15	#DIV/0!
14	R-21 24"OC + R-4	R-21 16"OC + R-4	$101.40	$0.00	$101.40	#DIV/0!
15	R-21 24"OC + R-4	R-21 16"OC + R-4	$105.73	$0.00	$105.73	#DIV/0!
16	R-21 24"OC + R-4	R-21 16"OC + R-4	$155.12	$0.00	$155.12	#DIV/0!

Conclusions

- First cost not a good measure of affordability
- Affordability of home a function of mortgage and other costs including energy costs
- Recommend minimum criteria of 1 year to positive annual cash flow.
- B/C ratio ≥1.3 results in 1 year to annual positive cash flow, 8 year payback of down payment (and 22 years of savings).
- CEC package would increase stringency:
  - 2 CZs of duct insulation increase
  - 13 CZs of wall insulation increased
  - 6 CZ's of roof deck insulation increase
  - 5 CZs of QII
  - 7 CZs of infiltration reduction
- Single measure evaluation is conservative, state definition of code evaluation is "cost-effective when taken in their entirety and when amortized over the economic life of the structure compared with historic practice."
- Recommend that CEC consider packages in their entirety and develop cut-off criteria based on cash flow and B/C rather than first cost

Single Measure Cost-effective Proposal (B/C > 1.0)

Climate Zone	Glass	Duct R-value	Infiltration	QII	Roof Deck Ins	Wall Ins
1	U32.S50	R-6	4 ACH 50	Yes	No	R-21 24"OC + R-4
2	U32.S25	R-6	4 ACH 50	No	R-13 Under	R-21 24"OC + R-4
3	U32.S50	R-6	7.5 ACH 50	No	No	R-21 24"OC + R-4
4	U32.S25	R-6	7.5 ACH 50	No	No	R-21 24"OC + R-4
5	U32.S50	R-6	7.5 ACH 50	No	No	R-21 24"OC + R-4
6	U32.S25	R-6	7.5 ACH 50	No	No	R-21 24"OC + R-4
7	U32.S25	R-6	7.5 ACH 50	No	No	R-15 16"OC + R-4
8	U32.S25	R-6	7.5 ACH 50	No	R-13 Under	R-15 16"OC + R-4
9	U32.S25	R-6	3 ACH 50	No	R-13 Under	R-21 24"OC + R-4
10	U32.S25	R-6	3 ACH 50	No	R-13 Under	R-21 24"OC + R-4
11	U32.S25	R-8	3 ACH 50	Yes	R-8 Over	R-21 24"OC + R-4
12	U32.S25	R-8	3 ACH 50	Yes	R-13 Under	R-21 24"OC + R-4
13	U32.S25	R-8	3 ACH 50	Yes	R-8 Over	R-21 24"OC + R-4
14	U32.S25	R-8	3 ACH 50	Yes	R-8 Over	R-21 24"OC + R-4
15	U32.S25	R-8	3 ACH 50	Yes	R-8 Over	R-21 24"OC + R-4
16	U32.S25	R-8	3 ACH 50	Yes	R-8 Over	R-21 24"OC + R-4

All changed cells shaded except change from 16” OC to 24” OC framing

1 Year Positive Cash Flow (B/C > 1.3) Proposal

Climate Zone	Glass	Duct R-value	Infiltration	QII	Roof Ins	Wall Ins
1	U32.S50	R-6	4 ACH 50	Yes	No	R-21 24"OC + R-4
2	U32.S25	R-6	4 ACH 50	No	No	R-21 24"OC + R-4
3	U32.S50	R-6	7.5 ACH 50	No	No	R-21 24"OC + R-4
4	U32.S25	R-6	7.5 ACH 50	No	No	R-21 24"OC + R-4
5	U32.S50	R-6	7.5 ACH 50	No	No	R-21 24"OC + R-4
6	U32.S25	R-6	7.5 ACH 50	No	No	R-15 16"OC + R-4
7	U32.S25	R-6	7.5 ACH 50	No	No	R-15 16"OC + R-4
8	U32.S25	R-6	7.5 ACH 50	No	No	R-15 16"OC + R-4
9	U32.S25	R-6	7.5 ACH 50	No	R-13 Under	R-21 24"OC + R-4
10	U32.S25	R-6	3 ACH 50	No	R-13 Under	R-21 24"OC + R-4
11	U32.S25	R-8	3 ACH 50	Yes	R-8 Over	R-21 24"OC + R-4
12	U32.S25	R-6	3 ACH 50	No	R-13 Under	R-21 24"OC + R-4
13	U32.S25	R-8	3 ACH 50	Yes	R-8 Over	R-21 24"OC + R-4
14	U32.S25	R-8	3 ACH 50	Yes	R-8 Over	R-21 24"OC + R-4
15	U32.S25	R-8	3 ACH 50	No	R-8 Over	R-21 24"OC + R-4
16	U32.S25	R-8	3 ACH 50	Yes	No	R-21 24"OC + R-4

All changed cells shaded except change from 16” OC to 24” OC framing